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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/817,056	03/27/2001	Kai Yang	50432-067	9188

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Washington, DC 20005-3096

EXAMINER

NGUYEN, THANH T

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 07/15/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/817,056

Applicant(s)

YANG ET AL.

Examiner

Thanh T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on 29 April 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-23 is/are pending in the application.
- 4a) Of the above claim(s) 13-20 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 6-12 is/are allowed.
- 6) ☒ Claim(s) 1-5 and 21-23 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 4/29/05.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Request for Continued Examination

The request filed on 4/29/05 for a Request for Continued Examination (RCE) under 37 CFR 1.114 is acceptable and an RCE has been established. An action on the RCE follows.

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 4/29/05 has been entered.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-5, 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al. (U.S. Patent No. 6,284,657) in view of Lou (U.S. Patent 6,493,270) and further in view of Chung et al. (U.S. Patent No. 6,017,817).

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Referring to figures 1, 4-8, Chooi et al. teaches a method of manufacturing a semiconductor device:

Forming a single first dielectric layer (18) overlying a substrate (10, see figure 1 and col. 5, lines 24-48),

Forming a first barrier layer (20, a silicon nitride layer, SiN, meeting claim 2, see col. 8, lines 9-11), comprising a first dielectric barrier material of silicon nitride (20) on the single first dielectric layer (18),

Etching to form a single opening (22) entirely within and defined by side surfaces and a bottom of the single first dielectric layer and a bottom (see figure 2, 4),

Forming a second barrier layer (15, a silicon carbide layer, SiC, called a “non-metallic layer” in Chooi et al., see figures 5, col. 6, lines 21-33, meeting claim 2), comprising a second dielectric barrier material of SiC (15) different from the first dielectric barrier material of silicon nitride (16, SiN), on and in contact with an entire upper surface of the first barrier layer (20, figure 5, wherein the second dielectric barrier (15) is on entire upper surface of the barrier layer (20) overlying the single first dielectric layer (18), on the side surfaces of the first dielectric layer (18) defining the first opening and on the bottom of the opening (22),

Etching, with selectivity to the first barrier layer (20), to remove the second barrier layer (15) from, and stopping on, the upper surface of the first barrier layer (20), and to remove the second barrier layer (15) from the bottom of the single opening (22), leaving a portion of the second barrier layer (15) as a liner (19) on the side surfaces of the single first dielectric layer (18) defining the single opening (22, see figure 6, col. 6, lines 34-49), and

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Filling the opening with metal (copper, meeting claim 5) to form a lower metal feature (see col. 7, lines 5-7),

In regarding to claim 3, depositing second barrier layer of silicon carbide (15) by chemical vapor deposition (CVD, see col. 6, lines 23-33, meeting portion of claim 3),

In regarding to claim 4, depositing first barrier layer of silicon nitride (16, SiN) at a thickness of between 500-5,000 Å (see col. 5, lines 35-45) and second barrier layer of silicon carbide (15) at the thickness of between 50-5,000 Å (see col. 6, lines 23-33).

Regarding to claim 21, etching to form the single opening (22) having entire side surface, which are substantially parallel (see figures 2, 4).

Regarding to claim 22, etching to remove the second barrier layer (15) leaving a portion of the second barrier as a liner (19) on the side surfaces of the single first dielectric layer (18) with a gap between an upper surface of the liner and an upper surface of the barrier layer (see figure 5, 6).

Chooi et al. teaches using silicon nitride layer as a cap layer (first barrier layer) and silicon carbide as a second barrier layer as shown in figures 1 and 4, but fails to teach that forming a single opening, depositing a silicon nitride layer by a Chemical vapor deposition method (CVD, as claimed in claim 3) and the gap range. Nevertheless, such processing step is known in the semiconductor processing art as evidenced by Lou and Chung et al.

Lou teaches forming a copper dual damascene or single damascene (see col. 7, lines 34-48).

Therefore, it would be obvious to a person of ordinary skill in the requisite art at the time the invention was made would form a copper single damascene in process of Chooi et al. as

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taught by Lou because forming single damascene or dual damascene interconnect is a design choice for an interconnection in the semiconductor device.

Chung et al. teach a method of forming a silicon nitride (208) cap layer by using CVD process (see col. 3, lines 25-29 and figure 2A).

Therefore, it would have been obvious to a person of ordinary skill in the requisite art at the time the invention was made would depositing a silicon nitride layer as first barrier layer and silicon carbide as second barrier layer by a CVD method in Chooi et al.'s process as taught by Chung et al. *because* depositing a silicon nitride layer by CVD process would provide a film layer having good thickness uniformity, high purity and good step coverage.

It would have been obvious to a person of ordinary skill in the requisite art at the time of the invention was made to optimize the gap range between an upper surface of the liner and an upper surface of the first barrier layer, since it has been held that where the general conditions of a claim are disclosed in the prior art (i.e.-the gap between the two layer), discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233 (CCPA 1955).

The specification contains no disclosure of either the critical nature of the claimed arrangement (i.e.- wherein gap is about 50-500 Å) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the applicant must show that the chosen limitations are critical. In re Woodruff, 919 F.2d 1575, 1578 (FED. Cir. 1990).

Allowable Subject Matter

Claims 6-12 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims because inter alia the prior art of record fails to disclose nor suggest to combine forming a third dielectric barrier layer on the first barrier layer and on upper surface of the lower metal feature, a second dielectric layer on the third dielectric barrier layer, a fourth dielectric barrier layer on the second dielectric layer, forming a third dielectric layer on the fourth dielectric barrier layer, forming a fifth dielectric barrier layer on the third dielectric layer, etching to form a dual damascene opening in the second and third dielectric layers over the lower metal feature, forming a sixth dielectric barrier layer comprising a sixth dielectric barrier material different from the first, fourth and fifth dielectric layers in the dual damascene opening, and filling the dual damascene opening with metal to form a metal line connected to an underlying metal via in the claimed invention as a whole.

Response to Arguments

Applicant's arguments filed 4/29/05 have been fully considered but they are not persuasive.

Applicant contends that Chooi et al. does not teach forming a single opening in a single dielectric layer. In response to applicant that Lou teaches forming a single opening in a single dielectric layer (see col. 7, lines 34-43).

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Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (571) 272-1695, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:00AM to 3:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached on (571) 272-1702. The fax phone number for this Group is (571) 273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (See **MPEP 203.08**).

A handwritten signature in black ink, appearing to read 'Thanh', with a long horizontal stroke extending to the left.

Thanh Nguyen
Patent Examiner
Patent Examining Group 2800